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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/812,035	03/30/2004	Linda T. Romano	108905.01	1425

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EXAMINER	
LOUIE, WAI SING	
ART UNIT	PAPER NUMBER
2814	

DATE MAILED: 10/25/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/812,035	ROMANO ET AL.	
	Examiner	Art Unit	
	Wai-Sing Louie	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 August 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,4-11 and 13-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,4-11 and 13-23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 4-7, 11, 13, 15, and 18-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hashimoto et al. (US 6,593,159), newly cited, in view of Kawai (US 6,239,033), Brown et al. (US 6,413,839), and CRC Handbook of chemistry and physics, 82nd Ed, by David Lide.

With regard to claims 1 and 4, Hashimoto et al. disclose a method of forming a semiconductor device (col. 8, line 35 et seq. and fig. 14), comprising:

- Forming a cavity 68 having a length, width and thickness in a body of a sapphire substrate 60 (col. 19, lines 52-59 and fig. 14b), the body having a thickness (col. 19, line 59), a bottom surface and a top surface (fig. 14b), the cavity opening onto at least the bottom surface (fig. 14b);
- Forming a semiconductor structure over the top surface and over the cavity 68 (fig. 14c), where at least one length and width of the cavity 68 is substantially greater than the corresponding length and width of the semiconductor structure (fig. 14c);

- Hashimoto do not disclose the substrate 60 having relatively low thermal conductivity and substantially filling the cavity 68 with at least one material having a greater thermal conductivity than the body. However, Kawai discloses the thermal conductivity of a sapphire body 21 is 0.4 W/cmK (Kawai col. 1, line 44) and filling the cavity 35 with Au film 37 (Kawai col. 11, lines 36-40). The CRC Handbook discloses the thermal conductivity of Au is 3.17 W/cmK (page 12-219). Thus, the thermal conductivity of filling material Au is greater than the body 21. Kawai teaches the Au filling in the cavity permits heat generated from the semiconductor structure to be radiated well to the Au film 37 and the heat of the semiconductor structure can be alleviated remarkably (Kawai col. 11, lines 36-40). Therefore, it would have been obvious to one of ordinary skill in the art to modify Hashimoto's device with the teaching of Kawai and the CRC Handbook to fill the cavity 68 with at least one material having a greater thermal conductivity than the body in order to radiate the heat from the semiconductor structure to the Au film.
- Hashimoto et al. do not disclose laser ablating forms the cavity in the body. However, Brown et al. disclose cutting into a sapphire substrate with laser ablation process (Brown col. 1, line 10 and col. 3, lines 22-42). Brown et al. teach the laser ablation is efficient, inexpensive, and no cutting tips to wear (Brown col. 2, lines 5-14). Therefore, it would have been obvious for the one with ordinary skill in the art to modify Hashimoto's device with the teaching of Kawai and Brown et al. to use laser ablation process to form the cavity in the body of the

sapphire substrate in order to have a efficient and inexpensive cutting process. Brown et al. disclose the cavity formed in the body of the substrate with an Nd:YAG laser (Brown col. 3, line 51).

With regard to claim 5, Hashimoto et al. modified by Brown et al. disclose the laser having a spot size of at least about 20 μm (Brown col. 5, line 9).

With regard to claim 6, Hashimoto et al. disclose the semiconductor comprises forming a GaN semiconductor structure (col. 19, lines 13-28).

With regard to claim 7, Hashimoto et al. modified by Kawai disclose the cavity is filled with Au (Kawai col. 11, lines 36-40).

With regard to claims 11 and 15, Hashimoto et al. disclose forming the semiconductor structure occurs after forming the cavity (fig. 14b and 14c).

With regard to claim 13, Hashimoto et al. disclose forming the cavity comprises forming the cavity 68 to a depth that is less than the thickness of the body 60 so that the cavity opens onto the bottom surface without opening onto the top surface (fig. 14b).

With regard to claims 18-19, Hashimoto et al. disclose a p-contact 66 and is aligned with the length of the cavity (fig. 14c).

With regard to claim 20, Hashimoto et al. modified by Kawai disclose the cavity is filled to maximize thermal conductivity and structural rigidity of the semiconductor structure device (Kawai col. 11, lines 18-39 and fig. 11).

With regard to claim 21, Hashimoto et al. modified by Kawai, CRC Handbook, and Brown et al. do not disclose the laser having a wavelength of about 1 μm. Since the applicant has not established the criticality of the wavelength stated and since these wavelengths are in

common use in similar devices in the art, it would have been obvious to one of ordinary skill in the art to use these values in the device. Where patentability is said to be based upon particular chosen dimension or upon another variable recited in a claim, the applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

With regard to claim 22, in addition to the limitations disclosed in claims 1 and 4, Hashimoto et al. modified by Kawai, CRC Handbook, and Brown et al. also disclose:

- The cavity comprises ablating the body with a laser (Brown col. 3, lines 22-41).
- The cavity forming a heat path that transports heat from the semiconductor structure away from the substrate (Kawai col. 11, lines 37-39).

With regard to claim 23, Hashimoto et al. disclose the thickness of the body (substrate) is at least about 150 μm (col. 2, line 39).

Claims 8-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hashimoto et al. (US 6,593,159) modified by Kawai (US 6,239,033), Brown et al. (US 6,413,839), and CRC Handbook of chemistry and physics as applied to claim 1 above, and further in view of Mistry et al. (US 5,731,046).

With regard to claim 8, Hashimoto et al. modified by Kawai and Brown et al. do not disclose filling the cavity comprises forming a seed layer on the inner surface of the cavity. However, Mistry et al. disclose forming a layer with a PECVD process via a seed crystal (Mistry col. 8, lines 5-9). Mistry et al. teach this technique would avoid any substantial physical damage to the substrate (Mistry col. 8, lines 12-13). Therefore, it would have been obvious for the one

with ordinary skill in the art to modify Hashimoto's device with the teaching of Kawai and Brown and Mistry et al. filling the cavity comprises forming a seed layer in order to avoid physical substantial damage to the substrate.

With regard to claim 9, Hashimoto et al. modified by Kawai, Brown, and Mistry et al. discloses forming an additional material 37 comprises plating process (Kawai col. 11, lines 7-9).

Claims 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hashimoto et al. (US 6,593,159) modified by Kawai (US 6,239,033), Brown et al. (US 6,413,839), and CRC Handbook of chemistry and physics as applied to claim 1 above, and further in view of Maeda et al. (US 6,189,771).

With regard to claim 10, Hashimoto et al. modified by Kawai do not disclose filling the cavity with a metal paste. However, Maeda et al. disclose using metal paste 5 to fill a cavity 3 on the substrate (Maeda col. 4, lines 12-14). Maeda et al. teach the metal paste provides a good contact with the cavity (Maeda col. 1, lines 40-47). Therefore, it would have been obvious for the one with ordinary skill in the art to modify Hashimoto's device with the teaching of Kawai, Brown et al., CRC Handbook, and Maeda et al. to provide a metal paste filling the cavity in order to make a good contact.

Claims 14 and 16-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hashimoto et al. (US 6,593,159) modified by Kawai (US 6,239,033), Brown et al. (US 6,413,839), and CRC Handbook of chemistry and physics as applied to claim 1 above, and further in view of Zhou (US 5,449,930), newly cited.

With regard to claims 14 and 17, in addition to the limitations disclosed in claims 1, 15 and 16 above, Hashimoto et al. modified by Kawai, Brown et al., CRC Handbook, and Zhou disclose the cavity comprises a first portion having a first depth that is less than the thickness of the body (under island 85 in Zhou fig. 10) and a second portion within the body having a second depth that is equal to the thickness of the body (Zhou fig. 10), so that the cavity opens onto the bottom surface and the top surface (Zhou fig. 10), the first portion having at least one of a width and a length that is greater than the second portion (Zhou fig. 10 to 12).

With regard to claim 16, in addition to the limitations disclosed in claim 1 above, Hashimoto et al. also disclose:

- Hashimoto et al. do not disclose the cavity has a depth that is equal to the thickness of the body. However, Zhou discloses a cavity has a depth that is equal to the thickness of the body 115 (Zhou col. 11, line 48 et seq. and fig. 15). Zhou teaches the cavity can best located underneath the semiconductor structure (Zhou col. 12, lines 21-22) with the heat conductor metal 133 filling the cavity (fig. 15) and thereby improving the heat dissipation (Zhou col. 4, lines 43-47). Therefore, it would have been obvious at the time the invention was made to modify Hashimoto's device with the teaching of Kawai, Brown et al., CRC Handbook, and Zhou to have a through cavity in the body in order to improve the heat dispersion of the semiconductor structure.

Response to Arguments

Applicant's arguments filed 8/14/2006 have been fully considered but they are not persuasive.

- Applicant argues that the combination of Hashimoto et al., Kawaii and Lide is both unpractical and non-obvious, in particular, fails to establish motivation for the alleged combination (page 7 of the remarks). However, Hashimoto et al. disclose the forming of a cavity in a body of a sapphire substrate (Hashimoto col. 19, lines 52-59 and fig. 14b), but do not disclose filling the cavity with a material having a greater thermal conductivity than the body. Kawaii discloses filling a cavity in the sapphire substrate with gold (Kawaii col. 11, lines 36-40). Kawaii provides a motivation is gold filling acts as a heat sink to remove the heat generated by the semiconductor device (Kawaii col. 11, lines 36-40). Lide of the CRC chemical and physical Handbook is to provide the evidence to proof the thermal conductivity of gold is greater than the sapphire substrate. Therefore, the combination of Hashimoto et al., Kawaii and Lide is proper.
- Applicant argues O'Brien does not relate to a semiconductor layer such as sapphire. However, O'Brien reference is no longer used in the present rejection and the argument is moot in view of the new ground(s) of rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wai-Sing Louie whose telephone number is (571) 272-1709. The examiner can normally be reached on 7:30 AM to 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

WAI-SING LOUIE
PRIMARY PATENT EXAMINER

Wsl
October 20, 2006.